Preface

Life is linked to liquid transport, and so are vital segments of economy. Pumping devices—be it the human heart, a boiler feeder or the cooling-water pump of a motorcar—are always part of a more or less complex system where pump failure can lead to severe consequences. To select, operate or design a pump, some understanding of the system is helpful, if not essential. Depending on the application, a centrifugal pump can be a simple device which could be built in a garage with a minimum of know-how—or a high-tech machine requiring advanced skills, sophisticated engineering and extensive testing. When attempting to describe the state-of-the-art in hydraulic engineering of centrifugal pumps, the focus is necessarily on the high-tech side rather than on less-demanding services even though these make up the majority of pump applications.

Centrifugal pump technology involves a broad spectrum of flow phenomena which have a profound impact on design and operation through the achieved efficiency, the stability of the head-capacity characteristic, vibration, noise, component failure due to fatigue, as well as material damage caused by cavitation, hydro-abrasive wear or erosion corrosion. Operation and life cycle costs of pumping equipment depend to a large extent on how well these phenomena and the interaction of the pump with the system are understood.

This book endeavors to describe pump hydraulic phenomena in their broadest sense in a format highly relevant for the pump engineer involved in pump design and selection, operation and troubleshooting. Emphasis is on physical mechanisms, practical application and engineering correlations for real flow phenomena, rather than on mathematical treatment and theories of inviscid flow.

The present 3rd English edition has been enhanced by:

1. As a novelty, Sect. 7.14 provides a *fully analytical* method for the design of radial impellers. It can be applied to any type of pump, any specific speed and any user-imposed boundary conditions. The method provides a *unique* geometry for any given set of specified design conditions: every designer gets (within minutes) exactly the same geometry. Apart from drastically speeding up impeller development, the goal is to eliminate the arbitrary elements from the design process and to reduce the uncertainty of performance prediction.

2. Hydraulic instabilities in pumps with double-entry impellers and double-volutes are discussed in Sect. 5.8.
3. The axial force on double-entry impellers is governed by the skewed velocity distribution at the impeller outlet; Sect. 9.2.4 provides data for estimating such effects. Further, equations are given for estimating the effect of complex impeller side room geometries on performance and axial forces.
4. Sect. 7.4 has been supplemented with additional information on sewage pump design. Sect. 9.3.9 provides detailed information on the hydraulic imbalance of single-channel impellers and correlations for predicting these forces.
5. With the object of helping with vibration diagnostics, Chap. 10 has been significantly enhanced by a more detailed discussion of various unsteady flow phenomena and their impact on hydraulic excitation forces. A physical model is presented for the axial thrust reversal in single-stage pumps with double-entry impellers. Some more interesting case histories concerning vibration problems have been added. The interaction of acoustic waves with the flow in the impeller channels and associated excitation forces is also discussed in chap. 10.
6. Sect. 6.8 has been expanded with a more detailed discussion of cavitation damage in diffusers and volutes.
7. Chapters 4 and 13 provide new insights and data on hydraulic losses including those in highly viscous fluids.
8. Chapter 16 on testing centrifugal pumps has been added.
9. Some printing errors were corrected and some additions were made in most of the chapters.

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